



Science Advice for EPA — Current and Future Challenges

*The EPA Science Advisory Board Staff Office and Science Advisory
Committees Accomplishments Report for Fiscal Years 2005 - 2008*





Letter from the Administrator

As someone who has spent 28 years at the Environmental Protection Agency, I can appreciate the role the Agency has played in shaping our nation's environmental accomplishments. Since EPA's founding, our nation's air is cleaner, our water is purer, and our land is better protected.

Over the years, EPA has become one of the most respected bodies within the scientific community worldwide. Much of the credit goes to the Science Advisory Board, the Clean Air Scientific Advisory Committee and the Advisory Council on Clean Air Compliance Analysis. By investing in quality science, these committees are doing their part to ensure our environmental success.

Not only have they helped ensure EPA uses the best science to support its decisions, but they have challenged the Agency to invest in forward-looking environmental research.

For example, the Science Advisory Board supported EPA's new homeland security responsibilities following Hurricanes Katrina and Rita. And last year, the Board published valuable research on remedying hypoxia in the Northern Gulf of Mexico. The Clean Air Scientific Advisory Committee has enabled this Agency to review criteria air pollutants at an accelerated pace. And the Advisory Council on Clean Air Compliance Analysis has helped EPA sharpen its analysis of economic benefits as an important input for environmental protection decisions.

These advisory groups are helping EPA better understand our environment and do more to protect the well-being of people in the United States and throughout the world.

I encourage you, as science advisors, to keep up the good work you are doing on behalf of EPA and the American people, and I pledge to you that I will do my part to continue to strengthen science across the Agency.

Stephen L. Johnson
Administrator



Letter from outgoing chair of the chartered SAB

Since October 1, 2004, the Science Advisory Board (SAB), along with Clean Air Scientific Advisory Committee (CASAC), and the Advisory Council on Clean Air Compliance Analysis (the Council), have provided advice on scientific and technical topics important to EPA. This report describes the wide range of topics addressed. Our efforts, as independent advisors to EPA's Administrator, spring from a shared commitment to help EPA develop and use the best science – and use it wisely – to protect human health and the environment.

We very much appreciate the dedication and cooperation we have witnessed in the Agency staff with whom we have worked over the last four years. Their sincere efforts to make our nation a cleaner, safer, and “greener” place are most impressive.

Over the past four years and across all our work, three opportunities for needed improvement stand out. First, EPA is seriously under-investing in the research that will be required to meet the Agency's needs in the years to come. Support for EPA's Office of Research and Development has declined by 14.2 percent since 2004, in constant 2008 dollars. With the research budget so tight, research has shifted to supporting short-term needs (e.g., data generation and methods development in support of existing regulatory programs). This is obviously important but it will not be sufficient to meet the nation's future needs. Threats to ecosystems and public health from changing energy requirements, climate change, population shifts, new materials, and new technologies require EPA to reframe its research programs and create robust new research efforts.

Second, EPA has very little staff capability – and funds almost no scientific research – in modern social, behavioral, and decision sciences. Yet the results of research in these fields are critical to adequately addressing issues such as sustainability, homeland security, disaster preparedness, risk communication, valuation, and environmental stewardship. The Agency needs to develop a strategy for developing this capability.

Third, the SAB's experiences assisting EPA after Hurricanes Rita and Katrina, as well as the experience of the SAB's Homeland Security Advisory Committee, have underscored the need for EPA to adopt a broader approach in preparing to address future environmental disasters. To assist in this effort, the SAB has prepared a report titled “Preparing for Environmental Disasters.” In addition to making a number of specific recommendations for improvements, this report recommends the establishment of a small interdisciplinary Environmental Disaster Assessment Team to help the Agency adopt a broader, anticipatory perspective.

The SAB is delighted that EPA has sought independent advice on so many issues and has a commitment to carefully consider that advice. My colleagues and I hope the Agency will benefit from the advisory efforts described in this report as EPA addresses the challenges ahead.

M. Granger Morgan, Ph.D., SAB Chair (FY 2005-2008)
Lord Chair Professor in Engineering, Department of Engineering and Public Policy,
Carnegie Mellon University, Pittsburgh, PA



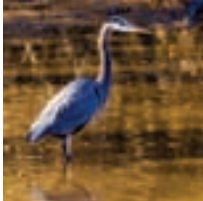
Letter from the SAB Staff Office Director

This *Accomplishments Report* illustrates how the Science Advisory Board (SAB), the Clean Air Scientific Advisory Committee (CASAC), and the Advisory Council on Clean Air Compliance Analysis (the Council) have responded to EPA's requests for science advice over Fiscal Years 2005-2008 and how the SAB has provided original strategic advice on key issues. This report covers a wide range of topics, reflecting EPA's mission and mandates and the recent developments in environmental sciences.

The SAB staff provides management and technical assistance so that the SAB, CASAC, and the Council can draw on the right experts to deliver high quality advice through an open, transparent process. The SAB staff seeks public nominations of experts for chartered committees, standing committees of the SAB, and the ad hoc panels and committees formed to address special topics. It is critical to involve experts who can provide impartial advice and meet the highest standards of ethics. The SAB staff seeks public comment on the proposed panel of advisers whenever we undertake a new advisory topic and has sought to increase the transparency of the advisory process through implementation of a new Web site and publications designed for the public interested in the science advisory committees and their work. In the last four years, we invited over 300 experts to serve on advisory committees and panels.

Reflecting on the accomplishments of the past four years, I thank Dr. Granger Morgan and all our advisors for their energy, for their insights, and their commitment to the mission of the Agency. I also extend thanks to members of the public who have attended advisory meetings and contributed comments for consideration by advisory members and to the SAB Staff who have supported the efforts described here.

Vanessa T. Vu, Ph.D.
Director, Science Advisory Board Staff



Missions of the SAB, CASAC, and Council

The Science Advisory Board (SAB), the Clean Air Scientific Advisory Committee (CASAC), and the Advisory Council on Clean Air Compliance Analysis (the Council) are independent, congressionally mandated advisory committees that provide advice to EPA's Administrator to strengthen the scientific and technical base for EPA's decisions. The three committees have different charters and different missions, but each provides science advice to EPA's Administrator through a public process governed by the Federal Advisory Committee Act (FACA).

The statutory mandate and charters of the different chartered advisory committees determine the scope of their activities. As EPA encounters new and controversial science issues, the Agency seeks advice. The chartered SAB also conducts original studies on emerging or overarching topics of importance to EPA.

SAB

Congress established the EPA Science Advisory Board (SAB) in its present form in 1978 through enacting the Environmental Research, Development, and Demonstration Authorization Act. This Act gave the SAB a broad mandate to advise the Agency on technical matters. The SAB's principal mission includes:

- Reviewing the quality and relevance of the scientific and technical information being used or proposed as the basis for Agency regulations
- Reviewing research programs and the technical basis of applied programs
- Reviewing generic approaches to regulatory science, including guidelines governing the use of scientific and technical information in regulatory decisions, and critiquing such analytic methods as mathematical modeling
- Advising the Agency on broad scientific matters in science, technology, social and economic issues, and
- Advising the Agency on emergency and other short-notice programs

The SAB has six standing committees: Drinking Water Committee, Ecological Processes and Effects Committee, Environmental Economics Advisory Committee, Environmental Engineering Committee, Exposure and Human Health Committee, and Radiation Advisory Committee.

Detailed information about SAB membership, activities, and reports can be found at: <http://www.epa.gov/sab>.



CASAC

The Clean Air Scientific Advisory Committee (CASAC) provides independent advice to the EPA Administrator on the technical bases for EPA's national ambient air quality standards for criteria air pollutants: carbon monoxide, lead, oxides of nitrogen; ozone, particulate matter; and sulfur oxides. The Clean Air Act requires periodic review of the science upon which the standards are based and the standards themselves.

Established in 1977 under the Clean Air Act Amendments of 1977 (see 42 U.S.C. § 7409(d)(2)), CASAC also addresses research related to air quality, sources of air pollution, and the strategies to attain and maintain air quality standards and to prevent significant deterioration of air quality.

The CASAC chair serves as a member of the chartered SAB.

Detailed information about CASAC membership, activities, and reports can be found at: <http://www.epa.gov/casac>.

Council

The Advisory Council on Clean Air Compliance Analysis (the Council) was established in 1991 pursuant to the Clean Air Act Amendments of 1990 (42 U.S.C. §7612) to provide advice, information, and recommendations on technical and economic aspects of analyses and reports EPA prepares on the impacts of the Clean Air Act Amendments on the public health, economy, and environment of the United States.

The Council reviews the data, methods, and cost-benefit analyses conducted by the Office of Air and Radiation for implementing its programs. EPA has to date issued one major retrospective analysis of the Clean Air Act for 1970-1990 and one prospective analysis for 1990-2010. EPA is planning a second prospective analysis for the 1990-2020 time period and has issued two analytic blueprints for this analysis.

Prior to Fiscal Year 2005, the Council provided advice on retrospective and first prospective studies and on the analytic blueprints for the second prospective study.

The Council chair serves as a member of the chartered SAB.

Detailed information about Council membership, activities, and reports can be found at: <http://www.epa.gov/advisorycouncilcaa>.



Key advice in Fiscal Years 2005-2008

This report highlights key advice provided by the Science Advisory Board (SAB), the Clean Air Scientific Advisory Committee (CASAC), and the Advisory Council on Clean Air Compliance Analysis (the Council). The descriptions illustrate how the committees have helped EPA address emerging or overarching topics of importance, plan for its science needs, advance strategic goals, strengthen scientific methods and assessments, and recognize excellent Agency research. Comments provided by the committee and panel chairs who steer these projects give a sense of the experience of the scientists who serve the Agency through the SAB, CASAC, and the Council. The full text of the reports and background information on the advisory activities can be found through the SAB, CASAC, and Council Web sites: <http://www.epa.gov/sab>; <http://www.epa.gov/casac>, and <http://www.epa.gov/advisorycouncilcaa>.

SAB original study on hypoxia

In 2006, EPA's Office of Water requested the SAB to consider the current scientific understanding of the causes of and solutions for hypoxia in the northern Gulf of Mexico, the so-called "dead zone" where oxygen levels are too low to support most marine life.

For this original study, the SAB Staff Office recruited ecologists, oceanographers, economists, agronomists,



and water experts to assess recent advances in the science surrounding the hypoxic zone in the Gulf of Mexico. In 2001, the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force issued an assessment of hypoxia in the Gulf of Mexico with the *Task Force's Action Plan for Reducing, Mitigating and Controlling Hypoxia in the Northern Gulf of Mexico*. The SAB was asked to evaluate the enormous body of science that has emerged since the 2001 report, and offer recommendations. In December 2007, the SAB provided the EPA Administrator with its report, *Hypoxia in the Northern Gulf of Mexico: An Update by the EPA Science Advisory Board*.

The report made several key recommendations to alleviate the Gulf's hypoxic condition during the

warmer months of the year: The SAB recommended a strategy of large reductions (at least 45 percent) in both nitrogen and phosphorous in the Mississippi watershed while warning that climate change will create conditions for which larger nutrient reductions would be required. The SAB also recommended tighter limits on nitrogen and phosphorus from municipal and industrial point sources, primarily wastewater treatment plants. The SAB stressed the need to address economic incentives that favored row crops (corn and soybeans) over more environmentally sustainable cropping systems like perennials. Additionally, the SAB expressed concerns about the effects of the national ethanol policy on corn production and hence, nutrient runoff into the watershed. Corn is increasingly grown for ethanol production, yet it yields a marginal amount of energy and burdens the environment because of the need for nitrogen and phosphorus fertilizers. The SAB recommended that the federal government fund more

research on environmentally friendlier crops such as switchgrass, and take a hard look at the incentives provided by current agricultural subsidies.

The report succeeded in evaluating the current state of the science to provide advice and recommendations that address ethanol production, a complicated issue of national concern. After the report was issued, EPA and other agencies participating in the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force developed the *Gulf Hypoxia Action Plan 2008*. The *Action Plan* embraced SAB advice to accomplish the Task Force's primary goal of reducing or making significant progress toward reducing the extent of the Gulf of Mexico hypoxic zone to less than 5,000 square kilometers by the year 2015. The Action Plan acknowledged the goal as an ambitious commitment that "takes into account the uncertainty of the task but attempts to maintain momentum and progress" and cited SAB advice supporting the goal.



The hypoxia zone in the Gulf of Mexico primarily results from land activities that occur on approximately 40 percent of the United States that drains into the Gulf. This timely report urges reduction in both total nitrogen and phosphorus in the river systems as may be achieved by use of perennial crops and other feedstocks for cellulosic ethanol.

Dr. Virginia Dale, Chair, SAB Hypoxia Advisory Panel
Corporate Fellow, Environmental Sciences Division, Oak Ridge National Laboratory,
Oak Ridge, TN

Advice for EPA science and research programs and priorities

The SAB reviewed EPA's planned science and research budgets for the upcoming fiscal years 2006 - 2009 and provided advice for the Agency and Congress to consider in making budget determinations. In addition, the SAB responded to EPA requests for outside advice on

individual, significant research topics. The chartered SAB also developed original advice on science for disaster preparedness and strategic research directions.

EPA's science and technology annual budget for Fiscal Years 2006-2009

The SAB identified consistent trends and delivered a consistent message over the four years covered

by this *Accomplishments Report*. The SAB found that environmental problems are growing steadily “more complex and challenging,” yet “overall levels of research support across the Agency’s Office of Research and Development (ORD) have fallen, in the aggregate, by about \$90 million (a drop of 14.2% computed as FY 2008 dollars) since 2004. If one excludes research related to Homeland Security the total decrease is \$97.1 million (a drop of 16.2%).”

In 2008, the SAB concluded that “despite the best efforts of the Agency’s scientific staff, with the research budget so tight, more and more of the research effort has shifted to supporting the short-term needs (e.g., data generation and methods development) of existing regulatory programs. This is important, but not sufficient to meet the nation’s future needs.” The SAB concluded that “research can only successfully provide the science to respond to the nation’s needs if senior leadership in the Agency and the Congress work to provide the resources needed to pursue a research program that fully supports EPA’s mission of protecting human health and the environment, now and in the years to come.” The SAB chair provided congressional testimony on the results of the SAB science and technology budget review – and SAB concerns about research funding – in 2005, 2006, and 2007.

In 2007, the EPA Administrator recognized the significance of SAB advice and recommendations on science planning through a Federal Advisory Committee Act Impact Award. In addressing the chartered SAB in December 2007, the Administrator observed that SAB review gave the Agency a better understanding of where EPA should shift science resources, how it could get more synergy from programs, and how to focus efforts and limited resource

Future research directions

To complement the annual budget review, EPA’s Office of Research and Development asked the SAB to consider where EPA research should be in 2012 and beyond and what factors EPA should consider for strategic planning. The SAB provided an initial report in 2008 with strategic advice about the Agency’s overall research

Strategic research direction change areas

- Broaden the interpretation of “land preservation” to take a greater leadership role in future land-use decision making and in managing the consequences of bio-fuels, sprawl, green-field development, and the pressures of unconstrained coastal development.
- Expand the focus on the environmental consequences of new technologies to include a broader consideration of the life-cycle of new products and their globalization.
- Expand the analysis of water infrastructures, supply, demand and quality in light of changing socioeconomic pressures and climate.
- Reinvalidate and modernize research on sensitive human and ecological populations.
- Improve the science foundation needed to respond to unexpected and emerging problems and environmental disasters.
- Expand policy-relevant research on developing, testing, and evaluating new and innovative alternatives to conventional command and control regulation.
- Improve dramatically the integration of economics and the decision and behavioral social sciences into research and policy development across the Agency.
- Continue to work on improving the effective communication of research results to potential users both inside and outside the Agency.

program in relation to both EPA's stated needs and the SAB's perspectives on the environmental challenges the Agency is likely to encounter. The SAB lauded EPA's willingness to engage the Board and others openly about research directions and strategies. The SAB recognized the importance of EPA's 16 specific research areas and urged the Agency to "adopt a more integrated view, one that recognizes the inherent complexities and interconnections among human and ecological systems, gives greater consideration to feedbacks, and focuses on the relevant scales of each issue." To truly protect the environment, the SAB emphasized that EPA must undertake a larger program of research that goes beyond its immediate regulatory needs to address the broad array of environmental problems facing the nation. The SAB identified several changes needed to address pressing environmental problems that do not fall neatly within existing regulatory mandates. Making these changes, in the SAB's view, could set a high standard internationally for creative, forward-looking, mission-motivated environmental research.

Environmental disasters

The SAB developed a self-initiated advisory report on planning for the use of science in future environmental disasters. This original report sprang from the SAB's experience providing rapid advice in the aftermath of Hurricanes Rita and Katrina (see discussion under "Health Communities and Ecosystems" on page 19) and stimulated SAB thinking about how disaster planning relates to strategic research directions.

The purpose of the environmental disaster report was to help EPA become more anticipatory and to think more broadly about how it identifies and assesses possible future large-scale environmental disasters and develops plans for responding to and communicating about them. The SAB advised EPA to systematically examine and learn from the best practices of other

organizations, public and private. The SAB also advised EPA to establish a small interdisciplinary environmental disaster assessment team to identify, prioritize, and assess potential environmental disasters and likely gaps in coverage. The report called on EPA to compile an inventory of existing models, tools, data, and resources, including those that, while developed for other purposes, might be made useful for disaster response, and then proceed to assess those tools and identify research needs. The SAB advised EPA to reinvigorate its program in behavioral social science research and emphasized the importance of including a strong program in empirically-based risk communication.

Research planning

As part of EPA's commitment to use "use of good science for good decisions," EPA's Office of Research and Development sought advice in Fiscal Years 2005-2008 on four areas where innovative science planning was needed.

Environmental clean-ups

To consolidate research planning related to environmental clean-ups, EPA's Office of Research and Development requested SAB advice on its multi-year plans for contaminated sites and Research Conservation and Recovery Act needs. The SAB found that the two related multi-year plans were sound and made "judicious use of leveraging opportunities to significantly stretch limited resources to meet more of the Agency's needs." The SAB suggested ways to merge the two plans and more clearly relate the research to the Agency's strategic goals and targets for clean-ups.

Sustainability

EPA's Office of Research and Development requested SAB advice on a sustainability research strategy and multi-year plan. EPA intended the plan to build a strong foundation for transitioning EPA from its

historical “single-media” or “stovepipe” approach to environmental protection to a systems approach. The SAB viewed the strategy as a new paradigm that explicitly embraced the application of life-cycle principles in support of short- and long-term risk management decisions. To further develop EPA’s approach to sustainability, the SAB recommended that EPA should:

- Better define terms associated with the sustainability strategy and the measurement of sustainability outcomes.
- Apply sustainability principles to address and resolve specific, multi-faceted environmental problems.
- Be creative and strategic in developing its human resources programs to encourage broad adoption and implementation of sustainability-based approaches to environmental protection across the Agency.
- Enhance the diffusion of environmental sustainability principles and practices within and outside the Agency.
- Build on widespread support for sustainability. Both sound science and senior management support can further the paradigm.
- Make judicious use of targeted collaborations with other federal agencies as well as the private sector.



In 2006, the Environmental Engineering Committee of the SAB developed an advisory on the EPA Office of Research and Development’s (ORD) Contaminated Sites and Resource Conservation and Recovery Act Multi-Year plans. Both multi-year plans are important programmatic roadmaps that not only describe the alignment of ORD’s research priorities with the Agency’s strategic objectives but also highlight the coordination efforts between ORD laboratories that have enabled ORD to effectively address the myriad research needs of EPA program and regional offices. Owing to the scientific similarity in proposed research described by each multi-year plan, the SAB endorses the Agency’s decision to merge the two documents.

In 2007, the Environmental Engineering Committee of the SAB reviewed the EPA’s Office of Research and Development’s Sustainability Research Strategy and the Science and Technology for Sustainability Multi-Year Plan. The strategy and multi-year plan highlighted the Agency’s new interdisciplinary approach to human health and environmental protection research. Establishment of the new research paradigm, which involves explicit consideration of the economic, social, and technical aspects of environmental risk management decisions, represents an important first step in the Agency’s transition from a media-specific regulatory framework to one that is systems based and supported by life-cycle principles.

Dr. Michael J. McFarland, Chair, SAB Engineering Committee (FY 2005-2007)
Associate Professor, Department of Civil and Environmental Engineering, Utah State University, Logan, UT

Ecological benefits

To strengthen its ability to assess the ecological benefits of its actions, EPA requested SAB advice on a draft *Ecological Benefits Assessment Strategic Plan*. The SAB commended EPA for innovative and creative recommendations in the draft plan, especially in the area of ecological assessment and emphasized the importance of an expanded interdisciplinary framework for evaluating the ecological effects of policies. EPA finalized the draft plan in light of the SAB's recommendations.



Strengthening EPA's ability to assess the value of ecological protection is a priority for the Agency because life depends on ecosystems and the services they provide. The goal of EPA's Ecological Benefits Assessment Strategic Plan is to improve the Agency's ability to identify, quantify, and assess the value of the ecological effects of its activities, thereby helping decision makers to make more informed choices among environmental policy options. The SAB Committee on Valuing the Protection of Ecological Systems and Services reviewed a draft of the plan in 2005 and provided advice to EPA on how to improve the draft plan and prioritize across the many issues and actions identified. The committee found merit in many of the recommendations of the draft plan and applauded this important step in strengthening the Agency's ability to engage in ecological assessments. The committee called on the Agency to implement actions identified in the plan and to invest in the research needed to fill key gaps in data and methods. The committee will be issuing an important report in the near future that provides advice on how the Agency can further improve its current approach to ecological valuation and support new research to strengthen the science base for future valuations.

Dr. Domenico Grasso, Chair, SAB Committee on Valuing the Protection of Ecological Systems and Services (FY 2005)
Dean of the College of Engineering and Mathematical Sciences, University of Vermont, Burlington, VT

Ecological research

Moving ahead to implement the *Ecological Benefits Strategic Plan*, EPA developed a strategy to reorient EPA's ecological research program around the concept of ecosystem services. EPA sought SAB advice on a draft *Ecological Research Program Strategy and Multi-Year Plan* that would focus on developing an understanding of the ways in which management choices affect the type, quality, and magnitude of the goods and services received from ecosystems.

The SAB commended EPA for developing a research program that, "if properly funded and executed, has the potential to be transformative for environmental decision making as well as ecological science." The SAB encouraged EPA to provide additional resources to support the research program and made specific recommendations regarding priority setting, linking research to decision making, interactions among research components, analysis of uncertainty, and evaluation of program success.



The Ecological Processes and Effects Committee provided advice on the Ecological Research Program's Multi-Year Plan, which proposes a new strategic research direction – quantifying ecosystem services and their contribution to human health and well-being. The committee was unanimous in its support for the research vision and concluded that, if adequately funded, the program could provide a strong foundation for incorporating the value of ecological goods and services into Agency decision making. The significance of the report lies in its support for the new research direction, although that support is tempered by a concern that adequate resources are not available to fully implement the visionary plan.

Dr. Judith L. Meyer, Chair, SAB Ecological Processes and Effects Committee (FY 2007-2008)
Distinguished Research Professor Emeritus, University of Georgia, Athens, GA

Advice supporting EPA's strategic goals

Clean air

Criteria air pollutants

Over Fiscal Years 2005-2008, CASAC provided advice to help EPA achieve its strategic goal “to protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced.” Key science advice assisted EPA in reviewing the science to set revised ambient air quality standards for three criteria pollutants: particulate matter, ozone, and lead. CASAC's charge was to provide advice to assist EPA in revising or establishing primary National Ambient Air Quality Standards (NAAQS) to protect public health “with an adequate margin of safety” and in revising or establishing secondary NAAQS to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

CASAC provided detailed advice at key steps in the NAAQS process. For each pollutant, CASAC provided advice and later peer reviewed EPA's assessment of scientific literature related to public health and welfare



effects, EPA's risk and exposure assessments, EPA's staff papers analyzing policy options, EPA's monitoring strategies, and the Agency's regulatory approach. CASAC's reports consistently emphasized the importance of the scientific credibility of EPA's NAAQS review. Maintaining this credibility became an important challenge, as EPA implemented a new NAAQS process to meet the goal of reviewing the air quality standard for each of the six criteria pollutants on a five-year cycle as required by the Clean Air Act. CASAC's advice pointed out areas where CASAC members believed EPA science should be strengthened or where they believed the science supported decisions different from those made by the EPA Administrator.



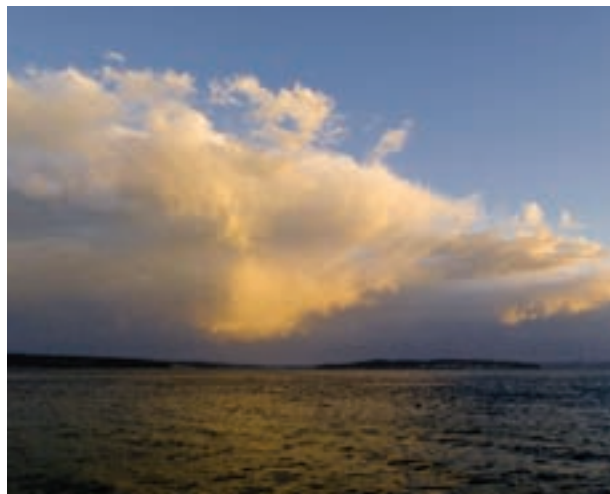
The period of 2005 to 2008 has been a time of change for CASAC. For the first time in the history of CASAC, the standards set by the Agency lay in part outside the range of recommended values given by CASAC. The reasons for such choices were often centered around uncertainty. The Clean Air Act states that the primary standards should be set with a “margin of safety” to account for such uncertainties. However, the Agency at times appeared to view uncertainty as a reason to delay action. More interaction between CASAC and the policy makers is needed to clarify how uncertainties will be handled in the future. Another change was the establishment of a new NAAQS review process. CASAC was pleased to see that some of their recommendations were incorporated into the new process, but is concerned about the deletion of the Staff Paper without adequate replacement of the scientific content of that document in the new Policy Assessment /Advance Notice of Proposed Rulemaking document. It is essential that the excellent scientific analyses of the EPA staff, which were formerly in the Staff Paper, be made available for review by the CASAC. I am confident that further dialog between CASAC and the senior-level management of the Agency can lead to inclusion of the scientific basis for alternative standards in the review process.

Dr. Rogene Henderson, Chair, Clean Air Scientific Advisory Committee (FY 2005-2008)
Senior Scientist Emeritus, Lovelace Respiratory Research Institute, Albuquerque, NM

Radiation monitoring

Building on its long history of advice for EPA’s radiation protection programs, the SAB provided advice in 2007 on an EPA plan to expand a system of strategically located fixed and deployable monitors that detect potentially hazardous levels of radiation deposition. The expansion was designed to better protect the public from potential terrorist attacks or from other radiological incidents. The SAB concluded that the newly configured RadNet system, the only system tracking radionuclide deposition nationwide, would enhance radiological air monitoring on a national scale. The SAB recommended adding state and nuclear facility monitors to future enhancements of the RadNet network. If these independent monitors were added to the network, over one thousand new monitors would potentially be incorporated into the RadNet infrastructure. After receiving SAB advice,

EPA increased RadNet’s capability to provide modeling data in emergencies and took several steps to improve monitoring, including improvements in geographic coverage without compromising population coverage.



Estimating radiation risks

In 2008, the SAB reviewed an EPA methodology for estimating cancer and genetic risks from low doses of low-linear-energy-transfer radiation. In its review, the SAB distinguished between the current state of scientific knowledge and the need for a practical, operational public health approach to radiation protection and standards setting. The SAB endorsed

EPA's proposal to estimate low-dose risks largely on the BEIR VII report developed by the National Research Council. The SAB provided advice on numerous technical aspects of adapting the approach and advised EPA to adopt additional measures of risk and uncertainty. EPA acknowledged the usefulness of SAB advice and committed to address SAB comments as it develops an assessment of radiation risks based on the methodology described in the white paper.



The SAB Radiation Advisory Committee (RAC) concluded that the proposed expansions and upgrades significantly enhance RadNet, but presented a somewhat different view with respect to the siting, sampling, and deployment of the fixed and deployable monitors in routine and emergency operations. The RAC made some suggestions for leveraging resources so that data gathered from other radiation monitoring systems can supplement RadNet. The RAC fully supported the need for exercises to test procedures for collecting, organizing, and disseminating information. The RAC commended EPA on including stakeholders in the Agency's ongoing planning and emphasized the importance of empirically testing and refining sample messages.

The RAC endorsed EPA's proposal to base its approach to low-dose risk estimation as recommended by BEIR VII. Specifically, for purposes of establishing radiation protection policy, the RAC endorsed EPA's use of a Linear Non-Threshold model combined with the Dose and Dose Rate Effectiveness Factor for estimating risks following low-dose exposures. However, the RAC emphasized the recent advances in the scientific knowledge of radiation biology and carcinogenesis, and advised the Agency to continue to monitor the developments of the biophysical models of radiation effects in the low-dose region. The RAC accepted the EPA's use of BEIR VII methodologies for deriving risk estimates for cancers of the stomach, colon, liver, prostate, uterus, ovary, bladder, other solid cancers, and leukemia, and recommended EPA use the BEIR VII methodologies for deriving risk estimates for radiogenic lung cancer. The RAC provided advice for deriving cancer risk in several areas not addressed by BEIR VII, including in utero exposure, bone cancer and non-melanoma skin cancer, but considered it premature to offer advice on estimating the risk of radiogenic thyroid cancer. The RAC agreed with EPA's exploration of alternative methods for estimating the relative risk for radiogenic breast cancer. Sources of uncertainty were discussed.

Dr. Jill Lipoti, Chair, SAB Radiation Advisory Committee (FY 2005-2007)
Director, Division of Environmental Safety and Health, New Jersey Department of Environmental Protection,
Trenton, NJ

Managing radiation risks

The SAB provided advice in 2008 on a draft supplement to a radiological survey and assessment manual developed by EPA in partnership with three other Federal agencies having authority and control over radioactive materials: the Department of Defense, Department of Energy, and the Nuclear Regulatory Commission. This effort represented the third formal review of federal inter-agency radiation-protection efforts within a decade.

The draft manual supplement addressed risks associated with materials and equipment potentially affected by radioactivity, including metals, concrete, tools, equipment, piping, conduit, furniture, and dispersible bulk materials such as trash, rubble, roofing materials, and sludge. The SAB observed that the manual may contribute significantly to radiation protection. The SAB provided suggestions to strengthen technical aspects of the document and improve its usability.



A panel of the SAB Radiation Advisory Committee reviewed this draft manual, the third of four detailed manuals written by federal radiation specialists from EPA, DOE, NRC, and DoD to guide radiological surveys of facilities and materials in the United States. SAB Radiation Advisory Committee panels also reviewed the two preceding draft volumes – one on site investigations and one on analytical laboratory protocols – which then were published in 1997 and 2003, respectively and are widely used to control the safe operation and decontamination of sites that may be radioactively contaminated. We anticipate that this draft also will be revised in response to panel recommendations, published, and applied.

Dr. Bernd Kahn, Chair, SAB Radiation Advisory Committee (FY 2008)
Professor Emeritus, Nuclear and Radiological Engineering Program, Georgia Institute of Technology, Atlanta, GA

Clean and safe water

Aquatic life criteria

As part of its effort to strengthen the science supporting clean water programs, EPA's Office of Water developed a strategy for revising the national guidance used to develop aquatic life criteria. This guidance is used by states and tribes to develop water quality standards. To ensure that criteria derive from the best available science, the Office of Water assessed the need to update the guidelines for aquatic life criteria. In that assessment, the Office of Water formed an interagency workgroup to review the state

of the science and recommend a framework for new or improved approaches for deriving ambient water quality criteria.

An SAB panel provided early advice to EPA on the proposed framework. Panelists expressed support for the Agency's efforts to incorporate kinetic modeling and a tissue-based approach into EPA's guidelines. SAB scientists commented on the scope of the proposed framework, scientific validity, and the appropriateness of proposed approaches and methods for water-based, tissue-based, and taxon-specific water quality criteria. EPA's Office of Water is working on several projects related to the consultation.



In the 20 years between the development of EPA's 1985 Aquatic Life Criteria Guidelines and the consultation, significant advances in the fields of ecotoxicology and exposure assessment had been made and the panel noted that it was important that an update of the 1985 Guidelines reflect the current state of the science. In general, the panel was complimentary of the work undertaken by EPA's Aquatic Life Criteria Guidelines Committee to incorporate kinetic modeling and a tissue-based approach. The proposed use of the Ecological Risk Assessment Framework as an organizing paradigm to the revisions was supported by the panel. A recommendation was made that as the guidelines are revised the Agency should consider and be guided by how proposed changes decrease

uncertainty in the ability of criteria to protect aquatic life. The panel encouraged case studies to demonstrate applications of the proposed revisions.

Dr. Kenneth Dickson, Chair, SAB Aquatic Life Criteria Guidelines Consultative Panel
Regents Professor, University of North Texas, Aubrey, TX

Measuring outcomes for drinking water protection

EPA's Office of Water sought SAB early advice regarding the science underlying several aspects of the drinking water program. One initiative involved a plan to develop meaningful and scientifically-based measures to link drinking water programs to public health outcomes for EPA's next Strategic Plan. The goal would be to link EPA program actions to potential decrease in waterborne disease incidents and to develop long-term measures that describe changes in chronic and acute disease due to microbes.

Members of the SAB's Drinking Water Committee found the effort worthwhile and important. They provided feedback on EPA's initial plans to strengthen the scientific credibility of the measures developed. They emphasized the importance of articulating the uncertainties associated with the indirect "progress measures" and the need to explore newer and better metrics that directly measure public health benefits

can be more in the future. After receiving the Drinking Water Committee advice, the Office of Water began to revise its "Measures Document" to incorporate advice on uncertainty and presentation of findings and to work with the Centers for Disease Control to enhance the waterborne disease surveillance system

Aircraft drinking water

EPA's Office of Water sought science advice on plans for a proposed regulation to address water systems onboard aircraft within U.S. jurisdiction. It sought this advice, because existing National Primary Drinking Water regulations were designed for traditional, stationary water systems. This science advice will also assist EPA's participation in the World Health Organization's efforts to develop international guidelines for aircraft drinking water.

Members of SAB's Drinking Water Committee provided advice on current and future statistical sampling of aircraft for drinking water quality and practical issues related to onboard water sampling.



Drinking water safety remains one of the great public health achievements in the United States. The SAB has played a significant role in the last few decades in assisting the EPA achieve some of the best water in the world and protecting our waterways. This has been addressed with examinations of emerging contaminants and of improved risk estimates for ecological and human health and now stretches around the world addressing water associated with our ability to travel. The views of outside scientists in the field who give of their time and expertise to advise the government are some of the key reasons that progress is made. I have been very privileged to have been able to be part of the EPA SAB which in my mind represents the best of our democratic system.

Dr. Joan Rose, Chair, SAB Drinking Water Committee (FY 2005-2008)
Homer Nowlin Chair in Water Research, Michigan State University, East Lansing, MI

Land preservation and restoration

EPA's Office of Solid Waste and Emergency, acting to meet two of EPA's commitments in its 2003-2008 strategic plan (to preserve and restore the land and to relate EPA program goals to performance), drafted an assessment of the retrospective benefits of the Superfund program, from 1980 to 2004, and sought SAB review. The assessment attempted to enumerate, describe, quantify, and monetize the benefits of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program, commonly known as Superfund. Under this law, the federal government responds directly to releases or threatened release of hazardous substances that may endanger public health, welfare, or the environment.

The SAB reviewed the draft, observed that estimating the full benefits of the Superfund program was an extremely important effort, and found that the assessment "falls short of the kind of estimate of benefits that we believe is needed." The SAB offered recommendations for improvements to be made in the report and offered a range of options for providing better estimates of the economic benefits of Superfund. The Agency is now considering alternative approaches to capturing the benefits of the Superfund program.





The Agency was attempting a daunting task in seeking a retrospective assessment of the benefits of the Superfund program over a 24-year period with limited analytical resources and severe data gaps. The panel attempted to make constructive suggestions that would help the Agency do a comprehensive and credible analysis of the program’s benefits for human health, ecological systems, and protection of groundwater.

Dr. A. Myrick Freeman, Chair, SAB Superfund Benefits Advisory Panel
Research Professor of Economics, Bowdoin College, Brunswick, ME

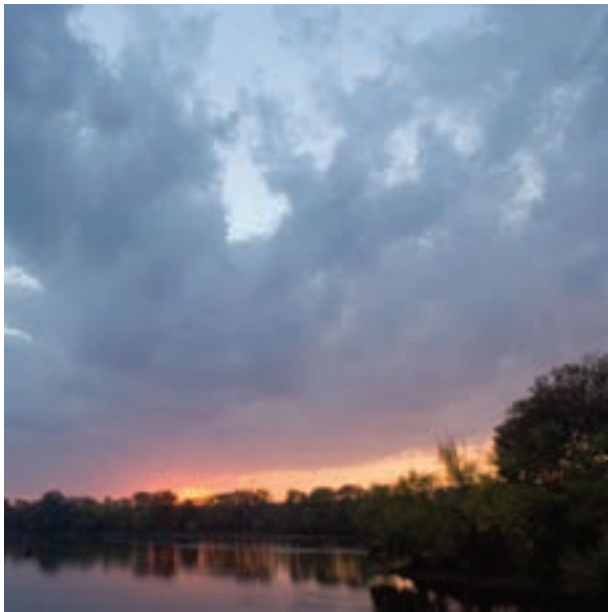
Healthy communities and ecosystems

Hurricane-related risks

In September 2005, EPA sought rapid consultative advice from the SAB on analytical plans to assess soil, sediment, water, and air contamination following Hurricanes Rita and Katrina. SAB staff convened workgroups of experts drawn from the SAB, CASAC, and the Council and their subcommittees. They worked

quickly to advise the Agency concerning timely and scientifically appropriate responses to the destruction and contamination along the Gulf Coast. Scientists on the EPA workgroups reviewed proposed analytical plans documents and provided advice to help EPA meet immediate needs to protect hurricane victims from environmental pollution. Based on their experience providing advice during the emergency, the SAB initiated an effort to provide additional, long-term advice to help EPA prepare for environmental disasters.

SAB Hurricane Workgroup Advisory Activities	EPA Requestor
Air Monitoring Plan	Office of Air and Radiation
Coastal Mississippi Water Quality Assurance Plan	Region 4 - Atlanta
Demolition and Disposal of Hurricane Debris	Office of Enforcement and Compliance
Assurance Soil and Sedi-ment Sampling Plan	Region 4 - Atlanta
Residue Sampling Plan	Region 6 - Dallas





The significance of this workgroup's effort was that we were able to respond very quickly to an emergency situation and provide expert advice to those on the ground dealing with Katrina's aftermath.

**Dr. Deborah Swackhamer, Chair, SAB Katrina Soil and Sediment Sampling Plan Workgroup
Professor of Environmental Health Sciences and Co-Director of the Water Resources Center, University of Minnesota, Minneapolis-St. Paul, MN**

In the immediate aftermath of the devastation of Hurricane Katrina, the SAB was called upon to help EPA Region 6 assess the human health risks posed by sediment residues deposited in flooded areas and homes of New Orleans and vicinity. Starting on Labor Day weekend, the SAB began work to review sampling plans assembled by Region 6 and its contractors. A highly qualified SAB workgroup was assembled and held a meeting to discuss the sampling plans less than two weeks after the hurricane. The workgroup demonstrated intense commitment and offered focused, practical recommendations which improved the Region 6 response to a critical situation. I was proud to be part of the effort.



**Dr. David Dzombak, Chair, SAB Workgroup on Residue Sampling Plan
Walter J. Blenko Sr. Professor of Environmental Engineering, Carnegie Mellon University, Pittsburgh, PA**

PCBs and the sinking of the Oriskany

Another example of SAB advice to help EPA protect healthy communities and ecosystems involved the sinking of a World War II-era aircraft carrier, the Oriskany, as an artificial reef in the Gulf of Mexico. In 2006, EPA's Region 4 requested that the SAB provide advice on the U.S. Navy's assessment of potential human health and environmental risks from polychlorinated biphenyl (PCB) risks associated with sinking of the decommissioned ship. Region 4 asked for assistance because the Navy applied for approval prior to sinking the vessel with non-liquid PCBs onboard, in accordance with the Toxic Substances Control Act and implementation of federal PCB regulations. Under those authorities, the EPA may approve such an application if the disposal action will not pose an unreasonable risk of injury to human health or the environment. EPA's Region 4 and EPA's Office of Pollution Prevention and Toxics asked the SAB to provide

advice on analyses conducted by the Navy to support its application for disposal of PCBs, including the model used to evaluate how chemicals might be released in the near-reef marine environment, PCB leaching studies, and the characterization of potential risks.

An SAB panel reviewed draft technical material and complimented the work undertaken. SAB scientists noted that while the draft risk assessment did not appear to indicate a significant risk, there were several limitations in the draft assessment. Panel members recommended ways to strengthen the models before they were applied in assessing the risk from the deployment of the ex-Oriskany as an artificial reef. They also noted that the models were not adequate to use in other naval reefing operations and recommended development of probabilistic models to better characterize the uncertainty inherent in the risk assessment.

The SAB advice guided EPA's decision to move forward with the project and to hold ongoing discussions with the Navy concerning PCB disposal approval for future artificial reefing projects. The Navy successfully sank the decommissioned Oriskany on May 17, 2006.

There have been changes and advancements in the science of risk assessment, in our ability to detect new contaminants and conventional contaminants with improved and novel methodologies at lower and lower concentrations, and in our understanding of the health effects associated with water contamination. Through the SAB advice on PCB disposal for the ex-Oriskany, the SAB assisted EPA in an examination of sensitive populations at risk and improved risk estimates for ecological and human health.

**Dr. Joan Rose, Chair, SAB Polychlorinated Biphenyl-Artificial Reef Risk Assessment Consultative Panel
Homer Nowlin Chair in Water Research, Michigan State University, East Lansing, MI (Photo page 18)**

Lead paint hazards

EPA's Office of Pollution Prevention and Toxics was concerned that lead renovation, repair and painting conducted by untrained and uncertified contractors might create new lead hazards, increasing the risk of lead exposure to the residents of homes containing lead-based paint. The office therefore sought advice on an assessment supporting a regulation to reduce risks from lead renovation, repair, and painting. The regulation intended to help attain the federal government's goal of eliminating childhood lead poisoning by 2010.

CASAC panel members provided specific advice to help EPA develop the assessment for the proposed

rule. They also peer-reviewed EPA's draft assessment approach. The panel found that "the OPPT Dust Study was reasonably well-designed, considering the complexity of the problem, and that the report provided information not available from any other source." CASAC found, however, that "the available experimental or empirical data are limited and that the modeling procedures and analyses are inadequate to support the proposed modeling approach for estimating the IQ changes in children exposed during renovation procedures." EPA issued a final rule on April 22, 2008, to address lead-based paint hazards. The regulation noted several CASAC concerns directly and identified EPA's differences with those conclusions, based on EPA's judgment of the "best information" supporting the final rule making.

The CASAC Lead Review Panel was invited to consult with the OPPT on their draft Lead Renovation, Repair, and Painting rule. The request came late in the LRRP rule development, a process that had lasted more than a decade. CASAC concerns included but were not limited to: a risk assessment relying on a Lead National Ambient Air Quality Standard that CASAC was recommending be greatly lowered; the need for more stringent cleanup protocols; and the absence of modern accepted techniques for elimination and monitoring of persisting lead residues. CASAC's recommendations were generally not accepted by the Agency.

**Dr. Rogene Henderson, Chair, CASAC Panel for Review of EPA's Lead Renovation Repair and Painting Activities
Senior Scientist Emeritus, Lovelace Respiratory Research Institute, Albuquerque, NM (Photo page 14)**

Advice on scientific methods and assessments

Economic analysis

Costs and benefits of the Clean Air Act

Over Fiscal Years 2005-2008, the Council provided advice to help the Office of Air and Radiation develop its next major study of the costs and benefits of the Clean Air Act Amendment (CAAA) programs, a mammoth study expected in 2009. The Council also responded to EPA's request for advice on technical issues arising from rule makings to protect air quality.

Because EPA's Office of Air and Radiation planned to strengthen assessment of ecological benefits for its next major study of air pollution benefits, the Council and its new Ecological Effects Subcommittee, established in 2004, met in 2005 to provide advice on "credible methods to quantify and monetize the effects of marginal changes in air pollution on ecosystem processes." The Council and its subcommittee supported EPA's plans for a qualitative characterization of the ecological effects of air pollutants throughout the country, an expanded literature review, and a quantitative, ecosystem-level case study of ecological service benefits as a solid foundation for subsequent work of broader scope.



Health benefits to humans from the Clean Air Act and its amendments have long represented the largest share of quantified benefits from this legislation. Benefits in terms of the health of ecosystems are much more diverse, much harder to measure in physical terms, and possibly more difficult to attribute directly to changes in air quality as opposed to other factors. Even when physical ecological effects can be identified, the literature is still spotty on the extent to which society values these types of ecological protections or improvements. This report steers the Agency towards some potentially more helpful case studies to assess rigorously the potential scope of ecological benefits that are presently omitted from benefit-cost analyses.

Dr. Trudy Ann Cameron, Chair, Advisory Council on Clean Air Compliance Analysis (FY 2005-2006)
Raymond F. Mikesell Professor of Environmental and Resource Economics, University of Oregon, Eugene, OR

The Council also provided detailed technical advice on air quality modeling issues, cost and uncertainty analyses, and EPA's case study of the health benefits of benzene reductions in Houston, 1990-2010. EPA is incorporating the Council's advice in each of these areas.



The series of congressionally-mandated reports estimating the benefits and costs of the 1990 Clean Air Act Amendments serve multiple purposes. First, they quantify the effects – both beneficial and adverse – of Clean Air Act regulations that are estimated to have the largest effect on the U.S. economy of any set of environmental regulations. Second, they provide a test-bed for developing methods to estimate benefits and costs that are subsequently used to evaluate new regulations. In support of both objectives, the Council was able to advise EPA on its proposed improvements in methods for estimating the costs of regulations and the benefits of regulating some of the 187 hazardous air pollutants, a class of pollutants that has not been incorporated in previous reports.

Dr. James K. Hammitt, Chair, Advisory Council on Clean Air Compliance Analysis (FY 2007-2008)
Professor, Center for Risk Analysis, Harvard University, Cambridge, MA

Air pollution regulatory analysis

EPA requested Council advice related to air pollution regulations because of the technical expertise of the Council and its subcommittees and their experience with air pollution cost-benefit issues. In 2006 EPA's Office of Air and Radiation requested an expedited review of a methodological assumption to be used in the benefit assessment to accompany rule making on the particulate matter NAAQS standard. EPA sought advice on how to address the historical problem of overestimating future emissions for the stationary non-electricity generating unit sector and proposed an interim method. The

Council recommended an alternative to an interim method proposed by EPA, specifically to “capture the underlying technological change that is likely driving the decline in emissions, i.e. the efficiency gains in production processes and improvements in air pollution control technologies that can be expected over time” by developing “surrogate metrics to capture this underlying technological change.”

EPA followed the Council's recommendation and developed methods for projecting emissions that incorporate technological change.

The Agency was concerned that its models to forecast future emissions of air pollution did not adequately account for systematic decreases in emissions as a result of technical changes. These changes include more efficient production technologies and air pollution control technologies. Failure to account adequately for technical change has likely resulted in overestimates of emissions. The Council and its Air Quality Modeling Subcommittee could not endorse an arbitrary offsetting correction that would consist of intentional omissions of increased emissions due to economic growth. Instead, they advised the Agency to develop defensible estimates of declines in “emissions intensity” due to technical change.

Dr. Trudy Ann Cameron, Chair, Advisory Council on Clean Air Compliance Analysis (FY 2005-2006)
Raymond F. Mikesell Professor of Environmental and Resource Economics, University of Oregon, Eugene, OR

EPA's Office of Air and Radiation and Office of Policy, Economics and Innovation also requested Council advice on the appropriate treatment of cessation lags, i.e., the time delay between reductions in air pollution and reductions in human health effects, in benefit assessments to support regulations related to particulate matter. The Council and its Health Effects Subcommittee considered a proposal developed by EPA in collaboration with the Office of Management and Budget. The Council acknowledged "considerable uncertainty" about cessation lags but emphasized the importance of using an approach based on air pollution evidence "generally suggestive of greater impacts in the first year relative to the proposed lag structure in question." The Council recommended that "EPA use a primary case where 30% of the mortality reductions occur in the first year, 50% occur equally in years 2 through 5, and the remaining 20% occur equally over years 6 through 20" and that EPA "(1) review and keep abreast of the emerging literature in this area; (2) provide the best available justification for the lag structure they use; and (3) strongly consider conducting sensitivity analyses of other possible lag structures."

The Agency subsequently adopted the Council's recommended function and has been using it for benefits analysis ever since.

Some of the acute health effects associated with air pollution may decline immediately when emissions are reduced. However, chronic health problems in the exposed population may take longer to resolve. In particular, if it takes a while for mortality rates associated with air pollution exposure to fall, it is inappropriate to portray the full benefits of air pollution reductions as starting immediately with the onset of emissions reductions. Measures of the physical health benefits must include a reasonable approximation to the actual time profile of these physical benefits. This time profile is also important to the process of calculating the present discounted economic value of the future stream of net benefits from the Clean Air Act. The Council and its Health Effects Subcommittee reviewed the Agency's assumptions about cessation lags in physical health benefits.

Dr. Trudy Ann Cameron, Chair, Advisory Council on Clean Air Compliance Analysis (FY 2005-2006)
Raymond F. Mikesell Professor of Environmental and Resource Economics, University of Oregon, Eugene, OR
 (Photo page 22)

In 2008, EPA's Office of Air and Radiation requested review of the use of an expert elicitation conducted to support a benefit assessment for the particulate matter NAAQS. Expert elicitation is a systematic process of formalizing and quantifying, typically in probabilistic terms, expert judgments about uncertainties. The Office of Air and Radiation asked the Council to review the design, implementation, and results of the expert elicitation and EPA's interpretation of those results within the particulate matter benefit assessment to guide potential use of expert elicitation for future benefit assessments.

The Council endorsed EPA's application of the expert elicitation results. The Council was asked whether

EPA's benefits assessment responded to the National Research Council recommendation to "move the assessment of uncertainties from its ancillary analyses into the primary analysis by conducting probabilistic, multiple-source uncertainty analyses." The Council responded: "Our answer is yes." The Council also noted ways EPA could improve its analysis and noted that "there is room for improvement in conveying the differences in assumptions (including the influence of key empirical studies) that drive the differences among experts' concentration-response functions.... the relative importance of various sources of uncertainty: both those that were quantified and those that were not quantified."

Estimates of the benefits and costs of environmental regulations are necessarily imprecise, because of uncertainty about the effects of the rule on consumer and firm behavior, emissions, environmental fate and transport, health and ecosystem consequences, and the valuation of these effects. Policy makers should understand the magnitude of this uncertainty, which arises from limitations of scientific understanding as well as from random sampling variation. Expert elicitation is an innovative method to quantify this uncertainty, and the Council commends EPA for testing the method in the important context of quantifying the mortality effects of air pollution.

Dr. James K. Hammitt, Chair, Advisory Council on Clean Air Compliance Analysis (FY 2007-2008)
Professor, Center for Risk Analysis, Harvard University, Cambridge, MA (Photo page 23)

Value of a statistical life

The EPA National Center for Environmental Economics requested the SAB's advice on how the Agency should use meta-analysis, which combines findings from many studies, to develop estimates of the value of reducing mortality risks – i.e., the value of a statistical life (VSL), a statistical estimate of the cost of EPA actions that may lead to one fewer death. The SAB's Environmental Economics Advisory Committee provided advice on how specific techniques, such as meta-

regression, should be used for benefit analyses. It advised EPA to develop criteria for acceptable studies to include in a meta-analysis, to determine which studies are appropriate for estimating value of a statistical life in a specific policy context, and to include both stated preference and revealed preference studies, as appropriate to the specific policy context. EPA is in the process of revisiting its guidance on mortality risk valuation and plans to seek SAB advice as the Agency continues its efforts to update its mortality risk valuation estimates.



An important question in valuing the life-saving benefits of environmental policies is how the value of reducing mortality risks varies with life expectancy. One approach to answering this question is to divide the Value of a Statistical Life by discounted remaining life expectancy to calculate a Value per Statistical Life Year (VSLY). The VSLY is multiplied by remaining life expectancy to value lives saved. This is equivalent to assuming that the Value of a Statistical Life is proportional to life expectancy. The Environmental Economics Advisory Committee judged that there is not sufficient evidence to support this assumption and advised the Agency not to use this approach.

Dr. Maureen Cropper, Chair, SAB Environmental Economics Advisory Committee (FY 2005-2006)
Professor of Economics, University of Maryland, College Park, MD, and Consultant, World Bank, Washington, DC

Illegal competitive advantage

EPA sought economic advice for benefit assessment for topics other than rule making. EPA's Office of Enforcement and Compliance Assurance requested SAB advice on a draft white paper addressing EPA's policy of recapturing violators' "illegal competitive advantage," i.e., the economic benefit gained by violators from noncompliance with environmental statutes. Whenever EPA can effectively measure the economic benefit that a violator may have knowingly gained from illegal activity, EPA historically has aimed to recapture that gain through its civil penalty program. Most of EPA's enforcement cases involving economic benefit have focused on the financial gain that arises from relatively straightforward delayed and/or avoided pollution control costs. The Agency's BEN (benefits) computer model calculates the economic benefit in those situations. EPA asked the SAB to review a draft white paper that addressed economic benefits to companies that did not fit the BEN model's simplified paradigm of avoided and/or delayed expenditures.

An SAB panel advised EPA to rethink its use of the term "illegal competitive advantage" and its approach

to economic benefits generally. "It would be more transparent to have only two categories: (i) when economic advantage is limited to delayed or avoided compliance costs; and (ii) when economic advantage includes profits on increased sales." The SAB advised EPA to examine the facts of each case in which revenues increase to estimate the changes in streams of revenue and/or production costs as well as delayed or avoided compliance costs. The SAB also considered some broader economic issues regarding the penalties for non-compliance. The panel noted that the "state-of-the-art in benefits estimation has progressed to the point where EPA should seriously explore how it might incorporate 'harm-based' measures into its penalty formula, at least for some types of environmental harm." The report discussed the potential of both revealed preference approaches (e.g., travel cost methodology) and stated preference approaches (e.g., contingent valuation) for harm-based measures.

After considering the SAB's advice, EPA plans to use a revised white paper as a basis for developing an enforcement strategy that addresses the calculation of economic benefit where that benefit is beyond the BEN model.

Our charge gave the panel an opportunity to draw on the economic theory of optimal penalties to suggest interesting new ways for the Agency to think about setting penalties for violations of environmental regulations. We highlighted the importance of considering the probability that a violation is detected leading to the imposition of a penalty and the possibility of setting penalties based on the harm caused by the violation instead of the benefit of the violation to the firm.

Dr. A. Myrick Freeman, Chair, SAB Illegal Competitive Advantage Economic Benefit Advisory Panel
Research Professor of Economics, Bowdoin College, Brunswick, ME (Photo page 19)

Climate change

As part of EPA's increasing focus on climate change issues, EPA's Office of Atmospheric Programs sought SAB advice evaluate the usefulness of a computable general equilibrium model for estimating the economic effects of climate policies. This regionally disaggregated model of the global economy, known as the Second Generation Model, uses input-output relationships and simultaneous equations to simulate activities in multiple markets in the economy, such as labor markets, energy fuels markets, and final goods markets.

After reviewing the model, the SAB's Second General Model Advisory Panel noted that the model had been a significant contributor to past analyses of climate policy but that it would not be satisfactory for future policy work without modification recommended by the panel to make the model significantly more useful. The SAB also advised the Agency to employ a portfolio of models rather than relying on any single model and noted that that a revised Second General Model would deserve a place in that portfolio.



The SAB advisory report on the Second Generation Model (SGM) helped identify important ways in which the model could be improved. In significant part because of the advisory report, the SGM's capabilities for climate policy analysis have expanded substantially and its results can now be viewed with more confidence.

Dr. Lawrence H. Goulder, Chair, SAB Second Generation Model Advisory Panel
Shuzo Nishihara Professor of Environmental and Resource Economics, Department of Economics, Stanford University, Stanford, CA

Ecological assessment

Ecological risk assessment

The SAB's major contribution to ecological assessment over Fiscal Years 2005-2008 was an original study to advance the science and application of ecological risk assessment in environmental decision making. This original report drew upon recent scientific advances and risk assessment experience to identify opportunities to improve the use of ecological risk assessment for environmental decision making at EPA. The SAB's Ecological Processes and Effects Committee held a public workshop in February 2007 to "evaluate the state of the practice." The workshop and SAB discussions

led to recommendations to advance the practice of ecological risk assessment in three main areas: product health and safety evaluations; management of contaminated sites; and natural resources protection.

The SAB commended EPA for its previous efforts to advance ecological risk assessment science and encouraged further integration of ecological risk assessment into environmental management decision processes. In its view, EPA's 1992 *Ecological Risk Assessment Framework* and 1998 *Guidelines* had greatly improved the state of the practice of ecological risk assessment not only in the United States, but around the world. The SAB noted that ecological risk assessments had been most effective when clear management goals

were included in the problem formulation. The SAB urged EPA to encourage problem formulation dialog between ecological risk assessors and stakeholders.

The SAB advised EPA to develop methods and tools to help decision makers consider the physical, biological, and socioeconomic contexts of their decisions. The SAB found that many risk assessments can be enhanced by innovative techniques to frame and test risk hypotheses and by using multiple lines of evidence to assess risks at higher levels of biological organization (population, community, and

landscape scales). The SAB also advised EPA to increase its understanding of and capacity to utilize ecosystem valuation methods. In addition, the SAB recommended that EPA undertake more systematic post-assessment monitoring to evaluate the beneficial ecological consequences resulting from risk management decisions.

EPA's Office of the Science Advisor has formed a cross-Agency workgroup to determine how the SAB's recommendations can be implemented to improve EPA's risk assessment practices.

This survey and analysis of ecological risk assessment in decision making shows that such assessments have been effective in defining the ecological problems and identifying information needs, especially when the goals of the assessment are developed in collaboration with decision makers, assessors, scientists, and stakeholders. Risk-assessment and monitoring programs can also reduce uncertainty and be used to evaluate risk-management decision outcomes.

Dr. Virginia Dale, Chair, SAB Ecological Processes and Effects Committee (FY 2005-2006)
Corporate Fellow, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN (Photo page 8)

After considerable planning and discussions, the Ecological Processes and Effects Committee held a workshop in February 2006 where 120 ecological risk assessors discussed their experiences with ecological risk assessment and provided advice on ways to advance the science of ecological risk assessment. The resulting report recognizes the accomplishments and strengths of the ecological risk assessment process and provides suggestions for enhancing its effectiveness. Its significance lies in the many years of experience that were captured in those suggestions.

Dr. Judith Meyer, Chair, SAB Ecological Processes and Effects Committee (FY 2007-2008)
Distinguished Research Professor Emeritus, University of Georgia, Athens, GA (Photo page 13)

In addition to providing original advice for EPA's long-term needs to strengthen ecological assessment, the SAB responded to several EPA requests for advice to meet regional needs for technical ecological risk assessment tools.

Critical Ecosystem Assessment Model

In 2005, EPA's Region 5, based in Chicago, requested advice on the Critical Ecosystem Assessment Model (CrEAM), a spatially explicit model developed for predicting the ecological significance of undeveloped land using ecological theory, existing data sets, and geographic information system (GIS) technology. Region 5 developed the CrEAM to assess the ecological significance of land areas across the states of EPA Region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin) and considered its use to identify significant ecosystems in order to target protection and restoration efforts in EPA Region 5.

After reviewing the CrEAM, the SAB noted that “tools like the CrEAM will facilitate access to environmental information early in the decision-making process at an appropriate spatial scale. ...the SAB enthusiastically supports the development of regional tools like the CrEAM.” The SAB commended Region 5 for efforts to incorporate an understanding of ecological condition in the environmental decision making process at EPA but noted that there are limitations associated with the methodological approach used. The SAB suggested appropriate uses of the model and areas where EPA's proposed uses of the CrEAM are not all fully supported. The SAB also recommended additional work to further validate the CrEAM methodology.

The SAB review shows that CrEAM can be effectively used to identify ecologically significant areas in Region 5 in order to quantify and track ecosystem quality, target areas for protection, prioritize protection activities, and provide information to conduct National Environmental Policy Act reviews. The report emphasizes that tools like the CrEAM will facilitate access to environmental information early in the decision-making process at an appropriate spatial scale.

Dr. Virginia Dale, Chair, Ecological Processes and Effects Committee (FY 2005-2006)
Corporate Fellow, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN (Photo page 8)

Regional Vulnerability Assessment (ReVA) Program

In 2006 EPA's Office of Research and Development requested SAB advice on the methodological approach used in EPA's Regional Vulnerability Assessment (ReVA) Program. The goal of EPA's ReVA Program was to develop tools and methods to estimate future ecosystem vulnerability and illustrate trade-offs associated with alternative environmental and economic policies. EPA asked the SAB to provide advice on improving the effectiveness of the ReVA web-based environmental decision toolkit for communicating ecological risk and conditions to risk managers.

The SAB affirmed the importance of developing a suite of tools to integrate and synthesize environmental data to provide screening level estimates of ecosystem vulnerability on a regional scale. The SAB concluded that the ReVA project offered real promise and warranted continued effort and resources and noted technical challenges that EPA should meet before implementing the ReVA tools.

EPA incorporated SAB recommendations to further develop the web-based toolkit, which is actively being used for environmental planning in at least four regions.



The SAB ReVA Advisory Panel provided an opportunity for eleven scientists to offer advice about an ambitious, innovative, and quite timely EPA initiative. ReVA is quite simply an effort to move ecological risk assessment from theory to practice at a broad national scale through the development of tools and methods to estimate future ecosystem vulnerability. This panel, as all other SAB panels on which I have served, exemplified the best of the peer review process. Careful deliberation by experts with the unified single goal of making EPA scientific initiatives and programs the best they can be.

Dr. Kenneth Cummins, Chair, SAB Regional Vulnerability Assessment Advisory Panel
Co-Director, Institute for River Ecosystems, Humboldt State University, Arcata, CA

Geographic Information System Screening Tool

EPA's Region 6 requested SAB review in 2006 of a Geographic Information System Screening Tool (GISST) that used geographic information system coverages and environmental and socioeconomic data to provide screening level assessments of the potential environmental vulnerabilities of project locations or the impacts of specified activities. Region 6 intended decision makers to use data gathered from the GISST to help prioritize potential project locations and alternatives and to help identify levels of environmental concern. EPA Region 6 asked SAB advice on the validity of the GISST methodology, the defensibility of the GISST results, and the usefulness of the GISST, particularly within the National Environmental Policy Act process.

The SAB reviewed the GISST and provided advice to strengthen the tool. The SAB noted the importance of providing additional information on vulnerability or impacts that could help evaluate potential environmental impacts of project alternatives. The SAB also recommended that EPA make more use of modern decision analytic and statistical science in its development of numerical scoring. The SAB advised EPA to draw upon the available expertise and large literature on multi-attribute decision making to further develop the GISST.

EPA Region 6 is developing a plan to address many of the statistical issues identified by the SAB in its review of the tool. EPA is using the GISST as a scoping tool in the National Environmental Protection Act process to identify and "red flag" potential environmental impacts associated with proposed projects.

The SAB report emphasizes that geographic information system (GIS) capabilities and data layers provide essential support for efficient, timely, and proactive National Environmental Policy Act evaluations and other regional responsibilities. The panel noted that GISST is an objective, spatially explicit tool for conducting initial, broad-stroke evaluations in a timely fashion. The SAB finds that it is reasonable and appropriate to use the GISST as a tool to "red flag" the potential environmental impacts of certain types of projects. The separate development of GIS-based tools and data by EPA program offices and regions is inefficient, given budgetary constraints and the common need for these kinds of products.

Dr. Virginia Dale, Chair, Ecological Processes and Effects Committee (FY 2005-2006)
Corporate Fellow, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN (Photo page 8)

Human health assessment

Over Fiscal Years 2005-2008, EPA requested SAB advice on strategic issues related to human health assessment and also requested SAB review of several chemical-specific health assessments.

Updating exposure guidelines and enhancing risk approaches

EPA's Office of Research and Development sought advice on approaches for updating EPA's *Guidelines for Exposure Assessment*, published in 1992 and EPA's principles and practices for risk assessment. In the exposure domain, EPA noted scientific advances relating to probabilistic risk assessment approaches, human activity factors, susceptible populations, and life stages as areas that suggested revisions to EPA's exposure guidelines. The Office of Research and Development sought SAB advice on the scope and direction of potential changes. EPA also sought SAB recommendations for improving risk assessment practices.

The SAB's Integrated Human Exposure and Environmental Health Committee recognized EPA

achievements in advancing human health risk assessment practices in many areas through use of sound principles and science, external peer review, and emphasis on transparency. The committee advised EPA to assess and prioritize the scientific and practical needs for improving human health risk assessment. The committee offered advice on the following five topics:

- Aggregate exposure and cumulative risk assessment
- Populations, groups, or life stages of potential concern
- Uncertainty and variability, including probabilistic analyses
- Involving communities and communicating results
- Use of data (mechanistic, models, genomics, computational toxicology, etc.) versus defaults.

In response, EPA noted the value of the SAB advice as it undertook two subsequent efforts: research and development of guidance to address aggregate exposure and cumulative risk; and consultation with the National Academies of Science and independent research to improve understanding and communication of uncertainty and variability in risk assessments.



While the Agency has conducted many exposure and human health risk assessments, the Agency's willingness to be scrutinized by outside experts demonstrates its commitment to continuous improvement. The committee commended the Agency for the numerous advances it has made, identified several areas for improvement, and recommended that the Agency develop a plan to prioritize the scientific and practical needs for implementing further advancements in assessment approaches. This consultation provided the opportunity not only for the Agency to obtain objective expert advice, but also for the committee members to understand more deeply about the scientific rationales behind Agency decision making and practices.

Dr. Rebecca Parkin, Chair, SAB Integrated Human Exposure and Environmental Health Committees (FY 2005-2006)
Professor and Associate Dean, Environmental and Occupational Health, George Washington University Medical Center, Washington, DC

Review of draft EPA human health assessments

Perfluorooctonoic acid

In 2006, the SAB completed peer review of EPA's draft risk assessment for perfluorooctonoic acid (PFOA). PFOA is a synthetic (man-made) chemical used in the manufacture of several commercially important products. PFOA had been detected in the blood of the general U.S. population, although EPA found that scientists do not fully understand how individuals are exposed to the chemical.

To determine whether environmental exposure to PFOA might pose a risk to human health, EPA assessed available information on the health effects and human exposure to the chemical. The draft assessment also compared measured human blood levels with the estimated PFOA blood levels that are not anticipated to produce (or can produce minimal) toxicities based on data in tested laboratory animals.

The SAB review panel endorsed EPA's risk assessment approach, particularly the inclusion of multiple non-cancer health endpoints for risk assessment and the use of PFOA blood levels as a measure of estimated dose. The SAB recommended the inclusion of additional non-cancer

health endpoints for risk assessment and the use of the benchmark dose method to better estimate potential risks. Three-quarters of the panel judged that the weight-of-evidence conclusion for the potential of PFOA to cause cancer in humans was more aligned and consistent with the hazard descriptor of "likely to be carcinogenic" as described in the Agency's cancer guidelines (i.e., 2003 EPA Guidelines for Carcinogen Risk Assessment). They recommended that a risk assessment be conducted for carcinogenic effects.

EPA acknowledged the value of SAB peer review "to ensure that the Agency is on a reasonable path handling a number of difficult, technical, and novel scientific issues that PFOA poses."

Following the SAB review, EPA planned research to develop a better and more complete understanding of the sources and pathways of exposure to PFOA and intends to integrate this new toxicity testing and mechanistic data into the risk assessment. In January 2006, EPA and the eight major companies in the industry created the 2010/15 PFOA Stewardship Program. The companies committed to reducing facility emissions and product content of PFOA and related chemicals by 95 percent by 2010, and to work toward eliminating emissions and product content by 2015.



PFOA and related chemicals are persistent in the environment and are found broadly in the blood of the general population, giving rise to concerns over their potential for bioaccumulation and toxicity. The majority view of the SAB review of the draft risk assessment for PFOA concluded that PFOA was a likely human carcinogen, and given the broad human exposure, also urged the inclusion of non-cancer health effects in the risk assessment. This panel also encouraged additional research to evaluate its developmental and nervous system effects which remain largely unknown at the current time.

Dr. Deborah Cory-Slechta, Chair, SAB PFOA Risk Assessment Review Panel

Professor, Department of Environmental Medicine, School of Medicine and Dentistry, University of Rochester, Rochester, NY

Arsenic health effects

In 2007, the SAB completed a report providing advice on several issues relating to the cancer hazards of organic and inorganic arsenic. EPA's Office of Research and Development, Office of Pesticide Programs, and Office of Water sought advice because organic dimethylarsinic acid was used as a weed killer and inorganic arsenic is generally a low-level contaminant in many drinking water sources, EPA asked the SAB to review two scientific documents that address the carcinogenicity of dimethylarsinic acid and inorganic arsenic. An expert SAB panel was formed to review and comment on key scientific issues presented in these two documents. The SAB supported the nonlinear approach for low-dose extrapolation of dimethylarsinic acid and the use of uncertainty factors to account for interspecies differences and human variability. For inorganic arsenic, the SAB supported the use of a linear cancer risk model, as recommended by the National Research Council in 2001. In reaching this conclusion, the SAB supported the use of available epidemiologic data despite current data limitations. The SAB noted the importance of continued research effort to strengthen EPA's cancer risk assessment for dimethylarsinic acid and inorganic arsenic.

EPA is considering the SAB's comments as the Agency completes the current cyclical reviews of current drinking water standards and Agency-wide hazard values for arsenic. EPA is considering SAB advice as it evaluates the registration status for dimethylarsinic acid-containing pesticides.



Arsenic is a worldwide problem because of its presence in waste dumps, pesticides, and water from geologic characteristics in certain areas of the world. The SAB review of the Agency's Arsenic Report emphasized how many issues in the biology, chemistry, degradation, mode of action, and health effects of arsenic still remain to be clarified. The scientists, toxicologists, epidemiologists, chemists, biostatisticians, who evaluated the literature highlighted for EPA the current state of scientific knowledge as well as the questions that still need future study in order to fully understand and assess the risks associated with this metal.

Dr. Genevieve Matanoski, Chair EPA SAB Arsenic Review Panel
Professor, Department of Epidemiology, Johns Hopkins University, Baltimore, MD

Ethylene oxide

In a third human health assessment peer review, the SAB responded to a request from EPA's Office of Research and Development for advice on ethylene oxide. Ethylene oxide is an industrial chemical used as a sterilizing agent for foods and medical supplies. EPA asked the SAB to comment on three issues regarding

ethylene oxide: the carcinogenic hazard; derivation of a cancer unit risk value for inhalation exposure to ethylene oxide; and uncertainties associated with the carcinogenicity assessment.

In the SAB's review, a majority of the panel agreed with the conclusion in EPA's draft document that the available evidence supports a descriptor of

“carcinogenic to humans,” although some panel members concluded that the descriptor “likely to be carcinogenic to humans” was more appropriate. The panel encouraged the EPA to broadly consider all of the epidemiological data in developing its final assessment.

As recommended by the panel, the Agency has solicited the aid of researchers outside EPA to reanalyze the database for ethylene oxide as part of the revision of the assessment



The SAB convened an expert panel to review the Agency’s draft evaluation of the carcinogenicity of ethylene oxide. Principal subjects for review were the Agency’s choice and rationale for a hazard descriptor of “carcinogenic to humans,” derivation of a cancer unit risk value for inhalation exposure to ethylene oxide, and uncertainties associated with the carcinogenicity assessment. The panel provided recommendations to improve both the technical basis for the assessment and its transparency. The dose-response assessment offered the opportunity for spirited discussion among the experts on the merits of linear versus non-linear extrapolation in the context of the mode of action of ethylene oxide, leading ultimately to the recommendation by several members of the Panel that both types of extrapolation should be considered.

Dr. Stephen Roberts, Chair, SAB Ethylene Oxide Review Panel
 Professor, Department of Physiological Sciences, Director, Center for Environmental and Human Toxicology,
 University of Florida, Gainesville, FL

Advice on multi-disciplinary science efforts

Because of the complexity of environmental issues, EPA science efforts increasingly involve scientists from multiple disciplines and require multi-disciplinary science advice. Over Fiscal Years 2005-2008 three SAB *ad hoc* panels provided key advice.

Metals framework

In 2006, the SAB provided advice on EPA’s draft framework for inorganic metals risk assessment at the request of EPA’s Office of Research and Development. EPA developed this draft framework to supplement previous EPA guidance for use in site-specific risk assessments, criteria derivation, and other similar Agency activities related to metals. The framework, based on the risk assessment paradigm, highlighted areas where consideration of metal-specific information was necessary

and advantageous when conducting risk assessments. It outlined recommendations for conducting risk assessment for inorganic metals and metal compounds, based on the unique attributes of these compounds.

An ad-hoc expert SAB panel commended EPA for initiating the development of a comprehensive risk assessment framework for metals and metalloids. It noted that the framework covered the main areas of concern to risk assessors but provided technical corrections and advice to strengthen the document. The SAB recommended that the document be restructured and revised to improve clarity and precision. Technical corrections and additions were also recommended.

EPA published the *Framework for Metals Risk Assessment* on March 8, 2007. The document incorporated comments and recommendations of the SAB.

This report, reviewing the Agency's draft framework, provided constructive advice for this important addition to the Agency's contributions in risk assessment science. Providing a framework for including metals in risk assessment was an important step, and we were pleased to provide suggestions for improving the framework.

Dr. Deborah L. Swackhamer, Chair, SAB Metals Risk Assessment Framework Review Panel
Professor of Environmental Health Sciences and Co-Director of the Water Resources Center, University of Minnesota, Minneapolis-St. Paul, MN (Photo page 20)

Regulatory environmental models

In 2006, an SAB panel from multiple modeling disciplines reviewed a major EPA effort to develop guidance for regulatory environmental models. This effort responded to a request from EPA's Office of Research and Development for review of Agency-wide draft guidance and a models knowledge base. EPA intended the guidance to outline best practices in the development, evaluation, and use of environmental models to inform regulatory decision making. EPA intended the knowledge base to serve as a web-accessible inventory of environmental models to promote transparency in the data, algorithms, assumptions, and uncertainties underlying models and enable model developers, model users, and analysts to more easily identify information needs.

The SAB commended the Agency's regulatory environmental modeling initiative for providing a much-needed vision for modeling across all EPA programs and offices. The SAB noted that the draft guidance provided a comprehensive overview of modeling principles and best practices. The SAB also expressed concern that EPA was not matching the vision with a commensurate and steady allocation of resources.

After receiving SAB advice, EPA improved the Internet-accessible Models Knowledge Base (http://cfpub.epa.gov/crem/knowledge_base/knowbase.cfm) designed to serve as an inventory of EPA's environmental models and to facilitate model selection. The Agency also committed to develop a final guidance document on environmental models.



The importance of modeling as a tool in understanding and managing environmental risks has grown considerably over the past 30 years. EPA uses models for a wide variety of needs from testing our hypotheses about how the environment functions, to the efficiency of environmental control technologies, to forecasts about the behavior of substances that are released into the environment, to human and ecological risk assessment, to the magnitude of costs associated with environmental protection. Modern environmental models affect the way environmental regulations are formulated, interpreted, and carried out. With such broad and pervasive responsibilities, it is important that Agency scientists and the regulated community are assured that the models used are based on the best science available, and that they are sufficiently robust, accurate, and verifiable. The regulatory environmental

modeling program within the Agency is a critical part of this assurance. The Models Knowledge Base is especially important because it will allow ready access to models by the scientific community. The EPA has sought, and the SAB has provided, advice and review on this program since the early 1980s, an excellent example of the value of scientific oversight to the Agency's regulatory needs.

Dr. Thomas L. Theis, Chair, SAB Regulatory Environmental Modeling Guidance Review Panel
Professor, Civil and Materials Engineering, and Director, Institute for Environmental Science and Policy, University of Illinois at Chicago, IL

Software evaluation for new and existing chemicals

In 2006 and 2007, the SAB also reviewed software used by EPA's Office of Pollution Prevention and Toxics to support regulatory decisions associated with new and existing chemicals regulated under the Toxic Substances Control Act and in other existing chemical assessment activities. EPA asked the SAB to review the ability of the Estimation Programs Interface Suite (EPI Suite™) software to estimate properties related to a chemical's environmental transport and fate.

The SAB commended EPA for the strategic decision to support the development of EPI Suite™ and to make it publicly available. It noted that the software may play a significant role in international regulatory activities and thereby support the efforts of emerging industrial economies to develop in an environmentally protective and sustainable manner. The SAB made several recommendations for improvements in the software's scope, accuracy, and ease of operations, including a recommendation that EPA should "increase its investments to expand the range of chemical categories over which the software can generate valid predictions, and the number of chemical properties that can be modeled as new scientific information becomes available."

By the end of 2008, EPA intends to make a new version of EPI Suite™ (version 4.00) publicly and freely available. The new version incorporates the SAB's recommendations to enhance existing models, program functionality, and appearance, including redesign of the user interface and other features to enhance the software's usability.

EPI Suite™ is an important Agency decision support tool that is employed to predict the toxicity, fate and transport of existing and new chemicals when measurement data is lacking. Owing to its scientific defensibility, ease of operation and transparency, EPI Suite™ has not only been successfully employed to support Agency decisions but also has been adopted by a number of emerging industrial economies to encourage environmentally-sustainable development.

Dr. Michael J. McFarland, Chair, SAB EPI Suite Review Panel

**Associate Professor, Department of Civil and Environmental Engineering, Utah State University, Logan, UT
(Photo page 11)**

Environmental indicators

In 2007, EPA's Office of Research and Development requested SAB review of the science underlying its draft *Report on the Environment 2007*, which aimed to update information in the *Report on the Environment 2003* and answer key questions concerning the status of and trends in the environment and human health. EPA asked the SAB to:

- Assess the adequacy of the approaches, processes, or frameworks used to answer specified questions

- Assess the adequacy of the technical content of the indicators with regard to completeness of the technical data used and the relevance of indicators to the areas of concern
- Evaluate the appropriateness of the conclusions in the *Report on the Environment 2007*.

The SAB commended EPA for its initiative in preparing this "unique but ambitious report" and noted advancement, compared to EPA's *Report on the Environment 2003*. The SAB provided advice to help the Agency improve the draft

so that it would meet its intended purpose more fully. It advised EPA to include long-term trend information to allow trend analysis for many indicators; improve on the criteria used for indicators that could allow use of valuable and relevant information to further analyze trends; and provide more data interpretation and discussion of conclusions supported by statistical analysis. In addition, the SAB advised EPA to develop an underlying scientific framework for the report.

The SAB provided recommendations to improve the current future *Reports on the Environment*. The SAB emphasized the significance of EPA's undertaking to improve the reports and underscored the need to devote adequate resources to the science required for them: It wrote that the *Report on the Environment* "has the potential to replace the sorely missed annual reports on the state of the environment once published by the Council on Environmental Quality. The value and importance [of the Report on the Environment] will continue to grow as pressures of population, energy use, urbanization, and

climate change lead to continued stress on environmental quality and impacts on health and ecosystems."

EPA's Office of Research and Development revised, updated, and refined the draft report in response to feedback from EPA's SAB. EPA published its *Report on the Environment 2007* in final form in May 2008. The document incorporated more than 80 revisions to address SAB comments. The Agency intends to address more of the SAB's recommendations as part of the Web-based presentation of the *Report*. In EPA's view, the *Report* compiles "the most reliable indicators currently available to answer 23 questions that EPA believes are of critical importance to its mission and the nation's environment." EPA also requested that the SAB establish a standing advisory committee to provide consultation on how best to implement many of the changes planned for the online and future paper editions of the *Report on the Environment* in response to the Panel's recommendations.

The Report on the Environment is one the Agency's most significant reports, and our review of this report has helped improve both the current report and future editions. We hope that the Agency will implement our recommendation to embed the report in its core mission-directed activities.

**Dr. Deborah Swackhamer, Chair, SAB Panel for the Review of EPA's 2007 Report on the Environment
Professor of Environmental Health Sciences and Co-Director of the Water Resources Center, University of
Minnesota, Minneapolis-St. Paul, MN (Photo page 20)**

Homeland security

EPA's assumed new responsibilities for emergency response cleanup, infrastructure and building protection, and advancing science to prevent and respond to terrorist events after the terrorist attacks of September 2001. EPA's new homeland security responsibilities prompted the Agency to request advice from the SAB. The Homeland Security Advisory Committee, established in 2005, responded to these requests.

In 2006, EPA's Office of Water and Office of Research and Development requested early advice on the development of EPA's Water Sentinel Program, a demonstration project proposed to design, deploy, and evaluate a model contamination-warning system for drinking water security. At the same time, the Office of Research and Development also requested early advice on standard analytical methods for laboratories responding with rapid analysis to terrorist incidents.

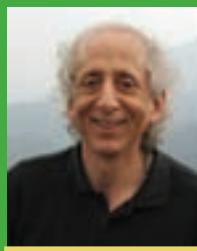
Members of the Homeland Security Advisory Committee provided advice regarding systems integration, sustainability of the programs, relevance for decision making, and transition to operational phases of the programs. They encouraged EPA to plan for interactions with a resilient public in the event of threats that are very difficult to predict.

In 2007 EPA's Office of Research and Development requested SAB advice on a prototype interactive online risk assessment and management software tool to provide health advisors and other emergency response officials with rapid access to critical information during an environmental emergency or training exercise. The Office of Research and Development planned to use the tool to help assess and provide site-specific numeric estimates of health risks for selected chemical, biological, and radiological threat agents and to help identify what response actions might be appropriate to mitigate health risks.

The SAB's Homeland Security Advisory Committee provided recommendations for development and testing of the tool and envisioned its most appropriate use a training context. The committee also emphasized that EPA should develop

a robust science program on risk communication: "Without rigorously developed and evaluated communications, the [Emergency Consequence Assessment Tool] may provide no value or negative value." EPA incorporated many of the SAB specific technical improvements into the tool and agreed that it could be most usefully employed in training responders. The Agency decided not to continue the development of the tool.

In 2007, the committee also reviewed the Agency's draft plans for a Microbial Risk Assessment Framework. The primary goal of the framework was to derive realistic, achievable, and acceptable risk-based decontamination goals (i.e., those that may be other than "zero-no growth in culture" as acceptable decontamination goals). The committee recommended that the framework be developed to give as quantitative a measure of risk as possible, given the available data, as one would employ when assessing chemical or food safety, which also faces data limits. Sources of uncertainty should be assessed as part of risk characterization to estimate the impacts of assumptions and defaults. EPA is moving forward to develop the framework based on specific recommendations of the committee.



Members of EPA's Homeland Security Advisory Committee are grateful for the opportunity to help the Agency in its important service to the nation's homeland security. EPA has vital responsibilities in ensuring the nation's resilience, in the face of multiple hazards. These lie primarily in the areas of emergency response, water protection, and the decontamination that is essential to restoring damaged properties to useful activity. EPA's staff has typically sought the committee's input at sufficiently early stages in its projects to allow the committee's advice to affect those projects' basic design, rather than just to suggest patches for potentially preventable problems. Many recommendations have focused on issues of system integration, needed to take best advantage of innovations in science and technology. EPA's ability to act on some of these recommendations has been hampered by its lack of expertise in the social and behavioral science, a deficiency that the SAB has identified in other areas as well.

Dr. Baruch Fischhoff, Chair, SAB Homeland Security Advisory Committee
Howard Heinz University Professor, Department of Social and Decision Sciences, Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA

Recognition of EPA scientists' achievements

In 2005, the SAB celebrated its first quarter-century partnership with EPA's Scientific and Technical Achievement Awards program. To support that program, the SAB has annually reviewed nominations of papers published by EPA scientists in peer-reviewed journals to

make recommendations for a highly significant award from EPA's Administrator. The SAB has supported the program to reward and encourage excellence in research at EPA and to raise the visibility of EPA's research in the scientific community. SAB advice in Fiscal Years 2005-2008 continued the tradition of supporting and strengthening the program and underlining the importance of peer review for Agency science.

Leadership and excellence of its scientific research programs are both key to the success of the missions of EPA. The Scientific and Technological Achievement Awards, given out annually following a review process by an SAB subcommittee, explicitly recognize excellence of EPA research in multiple different areas pertinent to the Agency. Not only do these awards recognize research that has made a significant scientific contribution that will benefit the Agency's ability to achieve its goals, but this Awards program provides critical SAB feedback to EPA as to important new areas of research to anticipate future needs.

Dr. Deborah Cory-Slechta, Chair, SAB Scientific and Technological Achievement Awards Panel (FY 2003-2005)
Professor, Department of Environmental Medicine, School of Medicine and Dentistry, University of Rochester, Rochester, NY (Photo page 32)

The annual Scientific and Technological Achievement Awards competition is a critical element of the Agency's science programs, providing public recognition and monetary awards for papers published annually by Agency personnel in peer-reviewed journals. Such feedback is an important way of encouraging high standards of accomplishment while simultaneously paying tribute to the Agency's world-class science.

Dr. Thomas Theis, Chair, SAB Scientific and Technological Achievement Awards Panel (FY 2006-2008)
Professor, Civil and Materials Engineering, and Director, Institute for Environmental Science and Policy, University of Illinois at Chicago, IL (Photo page 35)



Upcoming advice

Valuing the protection of ecological systems and services

Since November 2003, the SAB's Committee on Valuing the Protection of Ecological Systems and Services has worked to finalize an original study to assess Agency valuation needs and the current state of the art and science of valuing protection of ecological systems and services. The goal of the report is to identify key areas for improving knowledge, methodologies, practice, and research for ecological valuation. The committee focused on EPA needs for valuation in the following areas: national rule making, site-specific decision making, and valuation for use in regional partnerships. It reviewed a range of EPA analyses supporting those needs and assessed approaches and methods that offer promise for EPA's use.

In December 2005 the SAB held a public workshop on Science for Valuation of EPA's Ecological Protection Decisions and Programs. This workshop provided an opportunity for advisors across the SAB, CASAC, and Council to provide input on the committee's preliminary approach. It also provided an opportunity for feedback from the Agency and outside experts.

A final report is expected in 2008.

Reactive nitrogen: an integrated approach

In 2007, the SAB initiated an original study to assess the degree of integration among current EPA research programs and the extent of linkage among the effects that reactive nitrogen causes in the environment. Reactive nitrogen (Nr) refers to all biologically active, photochemically reactive, and radioactively active nitrogen compounds in the atmosphere and biosphere of the Earth. The SAB plans to explore the implications of these linkages for nitrogen research and risk management. The study aims to make recommendations for a more integrated research program on Nr and to identify opportunities of integrated research for nitrogen management.

The SAB is initiating this study because Nr compounds can cause multiple beneficial and detrimental effects in the atmosphere, in terrestrial ecosystems, in freshwater and marine systems, and on human health. Information to date indicates Nr is accumulating in the environment and that anthropogenic activity leading to Nr production has been shown to exceed that from natural systems.

The SAB held a public workshop in October 2008 to discuss the committee's preliminary work and to obtain feedback from outside experts.



Web site development

Deployment of a new SAB, CASAC, and Council Web site

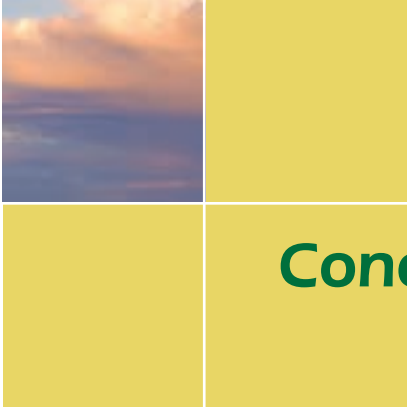
In November 2007, the SAB Staff Office implemented a new Web site for the SAB, CASAC, and Council and for the SAB Staff Office. The redesign of the site reflected changes in the organization of the committees and science advisory processes since 2000, including the 2002 introduction of the SAB's panel formation process, the 2003 restructuring of the SAB, and the acceleration in CASAC activities since the introduction of the new NAAQS process in 2007. Members of the public, Agency staff, and current and potential advisory committee members provided ideas for the redesign of the site. To obtain public input, the SAB sponsored public meetings in September 2002 to identify user needs and in July 2006 to receive feedback on a beta version of the site.

The SAB Staff Office envisions the Web site as a tool that provides current, consistent, and useful information about advisory activities and products in ways that increase public understanding of the science advice process. New features of the site include:

- On-line access to all SAB, CASAC, and Council reports

- Integration of all electronically available information related to a specific advisory activity on a single page (e.g. key information related to Agency requests, advisory committee or panel membership, *Federal Register* notices, related meetings, draft and final reports, Agency responses)
- Organization of CASAC activities and reports by CASAC topic and organization of SAB reports by major topic
- Access to all information relevant for a specific meeting on a single page (e.g. *Federal Register* notices, meeting agendas, materials, and minutes)
- Calendars of SAB, CASAC, and Council activities
- Information on advisory committees and panels and membership
- Information about public involvement in advisory activities, including public nomination of experts.
- Access to ethics information, including a new Confidential Financial Disclosure Form for Special Government Employees Serving on Federal Advisory Activities at the U.S. Environmental Protection Agency in 2008
- A powerful search function designed to locate and organize advisory reports and activities of interest to users.





Conclusion

As sources of information and opinion about environmental issues and environmental science proliferate, the science advisory committees supported by the SAB Staff Office play an increasingly important role. They provide a venue where EPA can bring urgent issues as well as strategic long-term issues to receive independent science advice in a public forum.

In the advisory process the public can observe scientific deliberations directly and contribute oral and written public comment. In the advisory process eminent scientists from different disciplines and perspectives weigh, balance, and integrate information and perspectives, discern common ground, and identify important uncertainties, knowledge gaps, and research priorities. Their goal is to provide the best advice, based on available science for environmental protection today and to plan for the science to meet future environmental challenges.

Membership on Chartered Committees and SAB Standing Committees, Fiscal Years 2005-2008*

Dr. Anna Alberini

Associate Professor
Department of Agricultural and
Resource Economics
University of Maryland
College Park, MD
SAB Environmental Economics Advisory
Committee (FY 2005-2008)

Dr. David Allen

Gertz Regents Professor
Department of Chemical Engineering
University of Texas
Austin, TX
Advisory Council on Clean Air Compliance
Analysis (FY 2005-2008)

Dr. Richelle Allen-King

Professor
Department of Geology
University of Buffalo
Buffalo, NY
SAB Ecological Processes and Effects
Committee (FY 2005-2008)

Dr. Melvin Andersen

Director
Computational Biology Division
Centers for Health Research
Chemical Industry Institute
of Toxicology
Research Triangle Park, NC
SAB Exposure and Human Health Committee
(FY 2007-2008)

Dr. Viney Aneja

Professor
Department of Marine, Earth
and Atmospheric Sciences
North Carolina State University
Raleigh, NC
SAB Environmental Engineering Committee
(FY 2005-2008)

Dr. Lynn Anspaugh

Research Professor
Department of Radiobiology
University of Utah
Salt Lake City, UT
SAB Radiation Advisory Committee
(FY 2005)

Dr. Fred Benfield

Professor
Department of Biological Sciences
Virginia Polytechnic Institute
and State University
Blacksburg, VA
SAB Ecological Processes and Effects
Committee (FY 2007-2008)

Dr. Gregory Biddinger

Coordinator
Natural Land Management Programs
Toxicology and Environmental Sciences
ExxonMobil Biomedical Sciences, Inc.
Houston, TX
Chartered Science Advisory Board
(FY 2005-2008)

Dr. Bruce Boecker

Scientist Emeritus
Lovelace Respiratory Research Institute
Albuquerque, NY
SAB Radiation Advisory Committee
(FY 2005-2006)

Dr. Thomas Borak

Professor
Department of Environmental and
Radiological Health Sciences
Colorado State University
Fort Collins, CO
SAB Radiation Advisory Committee
(FY 2007-2008)

Dr. Mark Borchardt

Director
Public Health Microbiology Laboratory
Marshfield Clinic Research Foundation
Marshfield, WI
SAB Drinking Water Committee
(FY 2006-2008)

Dr. Antone Brooks

Professor
School of Earth and Environmental Sciences
Washington State University-Tri-Cities
Richland, WA
SAB Radiation Advisory Committee
(FY 2005-2008)

Dr. Germaine Buck-Louis

Chief and Senior Investigator
Epidemiology Branch
National Institute of Child Health
and Human Development
National Institutes of Health
Rockville, MD
SAB Environmental Health Committee
(FY 2005-2006)
SAB Exposure and Human Health Committee
(FY 2007-2008)

Dr. Timothy Buckley

Associate Professor
Division of Environmental Health Sciences
The Ohio State University
Columbus, OH
SAB Integrated Human Exposure Committee
(FY 2005-2006)
SAB Exposure and Human Health Committee
(FY 2007)

*This list identifies members appointed by the EPA Administrator. The SAB Staff office has formed ad hoc committees and panels with over 300 additional consultants over Fiscal Years 2005-2008 to provide the technical expertise needed for many of the advisory reports discussed in this Accomplishment Report. The full roster of experts can be found on the SAB, CASAC, and Council Web sites as part of each final report.

Dr. Ingrid Burke

Director
Haub School and Ruckelshaus Institute of
Environment and Natural Resources
University of Wyoming
Laramie, WY
SAB Ecological Processes and Effects
Committee (FY 2008)

Dr. Thomas Burke

Professor
Department of Health Policy
and Management
Johns Hopkins University
Bloomberg School of Public Health
Baltimore, MD
Chartered Science Advisory Board
(FY 2008)

Dr. G. Allen Burton

Professor and Director
Cooperative Institute for Limnology
and Ecosystems Research
School of Natural Resources
and Environment
University of Michigan
Ann Arbor, MI
SAB Ecological Processes and Effects
Committee (FY 2006-2008)

Dr. Dallas Burtraw

Senior Fellow
Resources for the Future
Washington, DC
Advisory Council on Clean Air Compliance
Analysis (FY 2005-2008)

Dr. James Bus

Director of External Technology
Toxicology and Environmental Research and
Consulting
The Dow Chemical Company
Midland, MI
Chartered Science Advisory Board
(FY 2005-2008)

Dr. Gilles Bussod

Principal Scientist
New England Research
White River Junction, VT
Albuquerque, NY
SAB Radiation Advisory Committee
(FY 2005)

Dr. Trudy Cameron

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Eugene, OR
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Analysis (FY 2005-2006)
Chartered Science Advisory Board
(FY 2005-2007)

Dr. Peter Chapman

Principal and Senior Environmental Scientist
Environmental Sciences Group
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SAB Ecological Processes and Effects
Committee (FY 2007-2008)

Dr. Lauraine Chestnut

Managing Economist
Stratus Consulting, Inc
Boulder, CO
Advisory Council on Clean Air Compliance
Analysis (FY 2005-2006)

Dr. John Colford

Professor
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School of Public Health
University of California
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SAB Drinking Water Committee
(FY 2006-2008)

Dr. Loveday Conquest

Professor
School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA
SAB Ecological Processes and Effects
Committee (FY 2007-2008)

Dr. George Corcoran

Professor and Chairman
Department of Pharmaceutical Sciences
College of Pharmacy and Health Sciences
Wayne State University
Detroit, MI
SAB Environmental Health Committee
(FY 2005-2006)
SAB Exposure and Human Health Committee
(FY 2007-2008)

Dr. Deborah Cory-Slechta

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Rochester, NY
Chartered Science Advisory Board
(FY 2005-2008)
SAB Exposure and Human Health Committee
(FY 2008)

Dr. Ellis Cowling

University Distinguished Professor
At-Large Emeritus
Colleges of Natural Resources and Agriculture
and Life Sciences
North Carolina State University
Raleigh, NC
Clean Air Scientific Advisory Committee
(FY 2005-2008)

Dr. James Crapo

Professor
Department of Medicine
National Jewish Medical and Research Center
Denver, CO
Clean Air Scientific Advisory Committee
(FY 2005-2008)

Dr. Douglas Crawford-Brown

Professor Emeritus
Department of Environmental Sciences
and Engineering
University of North Carolina at Chapel Hill
Chapel Hill, NC
Clean Air Scientific Advisory Committee
(FY 2007-2008)

Dr. Noel Cressie

Distinguished Professor of Mathematical
and Physical Sciences
Department of Statistics
The Ohio State University
Columbus, OH
SAB Environmental Health Committee
(FY 2005-2006)
SAB Exposure and Human Health Committee
(FY 2007-2008)

Dr. John Crittenden

Richard Snell Presidential Professor
Department of Civil and
Environmental Engineering
Arizona State University
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SAB Environmental Engineering Committee
(FY 2005-2008)

Dr. Maureen Cropper

Professor
Department of Economics
University of Maryland
College Park, MD
Chartered Science Advisory Board
(FY 2005-2008)
SAB Environmental Economics Advisory
Committee (FY 2005-2006)

Dr. Kenneth Cummins

Co-Director
Institute for River Ecosystems
Humboldt State University
Arcata, CA
SAB Ecological Processes and Effects
Committee (FY 2005)
Chartered Science Advisory Board
(FY 2005)

Dr. Virginia Dale

Corporate Fellow
Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN
Chartered Science Advisory Board
(FY 2005-2007)
SAB Ecological Processes and Effects
Committee (FY 2005-2006)

Dr. Faith Davis

Professor and Senior Associate Dean and
Director of Graduate Studies
Department of Epidemiology
and Biostatistics
School of Public Health
University of Illinois at Chicago
Chicago, IL
SAB Radiation Advisory Committee
(FY 2008)

Dr. Ricardo DeLeon

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Chartered Science Advisory Board (FY 2008)

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Analysis (FY 2005-2008)

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SAB Exposure and Human Health Committee
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Analysis (FY 2007-2008)

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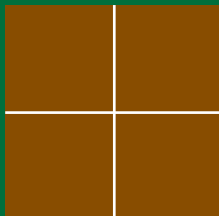
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Anthony Maciorowski	Biologist, Deputy Director
Thomas Armitage	Environmental Scientist
Kyndall Barry	Environmental Scientist
Wanda Bright	Staff Assistant
Fred Butterfield	Environmental Engineer
Daniel Fort	Environmental Protection Specialist
Jack Kooyomjian	Environmental Engineer
Tom Miller	Environmental Scientist
Angela Nugent	Environmental Protection Specialist
Carolyn Osborne	Management Analyst
Diana Pozun	Management Analyst
Resha Putzrath	Biologist
Debra Renwick	Management Analyst
Suhair Shallal	Environmental Scientist
Holly Stallworth	Economist
Patricia Thomas	Management Analyst
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Vivian Turner	Environmental Scientist
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Personal photos of committee and panel chairs courtesy of advisory members. Other photos by Eric Vance and other photographers, U.S. EPA, courtesy of U.S. EPA.



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